Published in final edited form as:
Health Educ Behav. 2011 August ; 38(4): 404–411. doi:10.1177/1090198110380544.

Testing hypothesized psychosocial mediators: Lessons learned in the MassBUILT study

Cassandra A. Okechukwu[1], **Nancy Krieger**[2], **Glorian Sorensen**[2,3], **Yi Li**[2,3], and **Elizabeth M. Barbeau**[4]

[1]Robert Wood Johnson Health and Society Scholars Program, University of California San Francisco, San Francisco, CA

[2]Harvard School of Public Health, Department of Society, Human Development, and Health, Boston, MA

[3]Dana-Farber Cancer Institute, Center for Community-Based Research, Boston, MA

[4]Health Dialog, Inc. Boston, MA

Keywords

smoking cessation; blue collar workers; mediation; occupational health; social contextual model

Introduction

Smoking remains a significant threat to the health of workers in what have traditionally been called “blue-collar” occupations, such as construction workers. According to National Health Interview Survey data from 1997 to 2004, blue-collar occupational groups had the highest smoking prevalence, with prevalence rates consistently above 30% across the category, and highest among construction workers – at 38% (Lee et al., 2007). Blue-collar workers have had a higher prevalence of smoking over time when compared to both the general population and white collar workers not only because they have higher rates of smoking initiation but also because they are less likely to successfully quit smoking (Barbeau, Krieger, & Soobader, 2004; Nelson et al., 1994; Sterling & Weinkam, 1976).

Workplaces have emerged as a successful medium through which interventionists can target and improve smoking cessation among blue-collar workers (Barbeau, 2001; Moher, Hey, & Lancaster, 2005; Sorensen & Barbeau, 2006). However, smoking cessation rates are often low in intervention studies targeting this population (Campbell et al., 2002; Moher et al., 2005; Willemsen, de Vries, van Breukelen, & Genders, 1998). Also, only a few of the interventions that target blue-collar workers have conducted formal analyses to evaluate the specific attributes of their intervention that are associated with success or failure (Armitage, 2007).

MassBUILT was a smoking cessation intervention for unionized blue-collar apprentices in the building trades industry. Informed by the social contextual framework (Sorensen, Barbeau, Hunt, & Emmons, 2004), a key goal of the MassBUILT intervention was to make the apprentices aware of the potential additive and synergistic cancer risk from the apprentices’ behaviors (smoking) in combination with exposure from their social context

Address communications and reprint requests to: Cassandra Okechukwu, Robert Wood Johnson Health and Society Scholars Program, University of California San Francisco and Berkeley, 3333 California St, Suite 465, San Francisco, CA 94709-0844; 415-613-6058 (office); 415-502-1010 (fax); cassandrao@post.harvard.edu.

(workplace). We anticipated that the majority of apprentices who were current smokers, like smokers in the general population, would have initiated smoking in their teen years. The start of their apprenticeship training program, however, would have constituted a 'teachable moment' to address potential on-the-job exposure to toxic dusts, chemicals, and fumes, many of which are either in cigarettes and/or react additively or synergistically with cigarette smoking.

The MassBUILT intervention achieved significant improvement in smoking cessation among the apprentices in the intervention versus the control group, measured one month after the intervention (OR=1.62; 95% CI 1.02 to 2.59) (Okechukwu, Krieger, Sorensen, Yi, & Barbeau, 2009). However, the difference in smoking cessation was not significant six months after the intervention despite our use of the social contextual framework and incorporation of occupational health and safety protection, for which there is strong empirical support as necessary component of smoking cessation interventions targeting blue-collar workers (Albertsen, Hannerz, Borg, & Burr, 2004; Okechukwu et al., 2009; Sorensen, Emmons, Stoddard, Linnan, & Avrunin, 2002; Sorensen et al., 1996).

In order to gain a fuller understanding of the factors likely to drive successful intervention, it is critical that we investigate whether hypothesized theory-based mediators operate as we expect them to. If not, such findings either lead us to question whether intervention methods need to be refined to better address mediators, and/or unidentified or unmeasured mediators were operating to achieve outcomes. Be they positive or negative, findings about the effects of hypothesized mediators nonetheless make an important contribution to our understanding of what works, does not work, and needs to be re-thought and tested in future studies aimed at identifying interventions to improve smoking cessation rates among blue-collar workers.

Our current analysis investigates the role of the two psychosocial factors, smoking decisional balance and dual hazard (risk perception of the dual hazards of smoking and harmful occupational exposures), which were the main targets of the MassBUILT intervention. An important goal of the intervention curriculum was to increase the apprentices' appraisal of the risk from dual hazards compared to exposure to smoking alone. In addition, we tried to influence the apprentices' perception of benefits and barriers to smoking (i.e. smoking decisional balance). We hypothesized that decisional balance and risk perception of dual hazards would be: (1) positively associated with smoking cessation, and (2) potential mediators of the intervention effects. As a multi-component intervention, we expected the hypothesized factors being investigated would be partial mediators of the relationship between the intervention and smoking cessation.

Participants and Methods

Study Sample

The MassBUILT study is a group randomized controlled trial that was delivered in collaboration with the Massachusetts Building Trades Council. The council is a collection of unions that each run apprenticeship training programs for individuals wishing to become unionized boilermakers, bricklayers, electricians, hoisting and portable engineers, ironworkers, painters, plumbers, pipefitters, sprinklerfitters, or refrigeration workers. After recruitment of apprenticeship programs, ten eligible sites that agreed to be part of the study were matched on size and randomly assigned to four intervention sites and six control sites. All apprentices at the sites were eligible to participate in the study.

We obtained survey data at all ten sites through written questionnaires at baseline (time 1), followed by a four-month intervention period in the intervention sites. Follow-up surveys were conducted one month (time 2) and at least six months (time 3) after the intervention.

The Dana-Farber Cancer Institute Institutional Review Board approved all the methods and materials used in the study. Among an embedded cohort of 1213 apprentices for whom we had survey data for all three time points of the study, 490 apprentices met our definition for smoking at baseline (i.e. smoked at least 100 cigarettes in lifetime and also smoked at least once in the last 30 days).

Intervention and control conditions (Independent variable)

The control sites participated in all survey periods and only received the intervention after we completed all study data collection. The apprentices in the intervention sites received a multi-pronged intervention, conducted over four months. The intervention was based on the US Public Health Service treatment guidelines for tobacco use and dependence (Fiore, Bailey, & Cohen, 2000). Also, we drew from materials and approaches of BUILT (Building Trades United to Ignite Less Tobacco)—a project of the Labor Occupational Health Program at the University of California, Berkeley and the state building and construction trades council of California (2006).

We supplemented the curriculum for all apprentices in the intervention sites to include two one-hour modules that focused on occupational hazards encountered in the building trades. These modules stressed that exposure to toxic agents can be made even more hazardous in the presence of cigarette smoking and exposure to secondhand smoke. In addition, the intervention sites had a series of five posters that reinforced key concepts from the BUILT Toxics and Tobacco curriculum modules and that reiterated the increased health risk due to exposure to both occupational hazards and smoking. The intervention also included eight weekly group counseling sessions led by state certified tobacco treatment specialists. The specialists, trained in motivational interviewing techniques for smoking cessation, led discussions of the benefits of and barriers to tobacco use and cessation with the aim of showing the participants that there are more barriers than benefits to smoking.

Sociodemographic Characteristics

Apprentices self reported their race/ethnicity, age, educational attainment, gender, and income in the baseline survey. We collapsed race/ethnicity into Hispanic, Black, White and additional race/ethnicity (a group which constituted only 4.7% of the study population and included American Indians, Hawaiians, Asians and multiple races). Due to the small number of apprentices who smoke reporting that they were of Hispanic ethnicity (n=8), we further combined this group with the additional race/ethnicities category during data analyses. We categorized educational attainment as less than high school, high school or GED, some college or 2 yr degree, and 4 years or more. The less than high school and high school or GED categories were further collapsed into one category during data analysis because only four apprentices in the intervention and three in the control group reported having less than high school education. We also collapsed household income from seven $10,000 increments from under $10,000 to $75,000 or more into four categories (<$25,000, $25,000–$49,999, $50,000–$74,999 and ≥$75,000). At the time of conducting this study, the official US poverty threshold for a household of 2 adults and 2 children was $19,806 (US Census Bureau, 2006).

Outcome Measures

The primary outcome for the study is smoking cessation at time 2, the point at which the intervention was successful, defined as a 7 day point prevalence abstinence from smoking (Question: Have you smoked a cigarette, even a puff, in the last 7 days; Answer options: yes or no). The secondary outcome is prolonged abstinence from smoking for at least 6 months from the time of data collection at time 3. We opted not to conduct biochemical verification of smoking status at the apprentice sites because union leaders advised us that any biological

tests would likely be misinterpreted by the apprentices as a drug test, and would in turn lead to deep mistrust of study staff and interventionists. Survey assistants stressed the confidentiality of the survey and also reiterated that truthful reporting of smoking status is important to the ability of the team to develop effective smoking cessation interventions.

Psychosocial Variables

Decisional Balance—We used the six item smoking decisional balance scale, which has been validated and shown to be invariant across sociodemographic groups, to calculate decisional balance for each study participant (Velicer, DiClemente, Prochaska, & Brandenburg, 1985; Ward, Velicer, Rossi, Fava, & Prochaska, 2004). Smoking decisional balance, as conceptualized in the transtheoretical model, captures the cognitive and motivational shifts as people weigh the benefits of and barriers to smoking (Migneault, Adams, & Read, 2005; Velicer et al., 1985). Smoking cessation is expected when the barriers to smoking outweigh the benefits of smoking.

To calculate smoking decisional balance score, the pro items (benefits to smoking, such as smoking relieves tension) and the con items (barriers to smoking, such as I'm embarrassed to have to smoke), which are both scored on a five-point scale, are first averaged separately. Then, the average score for the pro items is subtracted from the average score for the con items to come up with a score between −4 (many barriers to smoking) and 4 (many benefits to smoking) for each participant. To make the results of the decisional balance measure more intuitively interpretable, we subtracted the mean of the con items from the mean of the pro items, hence, reversing the meaning of the scores to be −4 (many benefits to smoking) to +4 (many barriers to smoking). Change in decisional balance was created by subtracting post-intervention from pre-intervention scores. The internal consistency reliability of the decisional balance scale in our participants ranged from 0.78 to 0.80 for the pro items and 0.70 to 0.76 for the con items.

Dual Hazard—Using three questions, we asked apprentices to rate their risk of getting cancer or other diseases as either very low, low, high or very high for each of the following exposures: (1) smoking, (2) dust, chemicals and fumes on the job, and (3) smoking and exposure to dust, chemicals and fumes on the job. We subtracted each apprentice's response to question 3 (exposure to smoking and exposure to dust, chemicals and fumes on the job) from their response to question 1 (exposure to smoking). We expect that after the intervention, the apprentices in the intervention group will rate their health risk from dual hazard (question 3) higher than their health risk from smoking alone (question 1). Therefore, the difference will be positive and higher after the intervention compared to before the intervention. We calculated change in dual hazard by subtracting post-intervention from pre-intervention scores. We found a 0.77 to 0.79 internal consistency reliability for the dual hazard scale from pre to post intervention.

Statistical Analysis

Data analysis started with descriptive analyses of the demographic characteristics of the apprentices in the intervention and control groups. All multivariable analyses controlled for age, gender, race/ethnicity, education and income. Our analyses followed the intention to treat principle; therefore, all apprentices at the intervention sites were classified as part of the intervention group regardless of their level of participation. The workplace is the unit of randomization and intervention in the study; thus, we expected potential clustering by workplace. To account for clustering, we controlled for the random effect of workplace and conducted all multivariable analyses in SAS version 9.1 using Glimmix for binary outcomes and Surveyreg for continuous outcomes.

A substantial number of study participants (18.6%) were missing data on at least one key sociodemographic variable. Therefore, we used the Amelia II program, a bootstrapping-based algorithm that multiply imputes missing data in cross-sectional or longitudinal settings, to create 10 multiply-imputed datasets (King, Honaker, Joseph, & Scheve, 2001). We then used the MIANALYZE procedure in SAS to combine results from modeling the multiple imputed datasets.

Our multivariable analysis started with an evaluation of whether these variables were mediators of the intervention. Using the Baron and Kenny method (Baron & Kenny, 1986), we implemented sets of multivariable linear and logistic regressions. However, we did not follow the conditional nature of the Baron and Kenny method because we were still interested in the relationship between the psychosocial variables and our intervention even if the variables were not formal mediators.

Prior analysis already showed us that the intervention was effective at time 2 (Okechukwu et al., 2009). To evaluate whether each psychosocial variable changed as a result of the intervention, we modeled change in scores as the outcome and intervention group as the main predictor controlling for age, gender, race, education and income. To evaluate if psychosocial variables were associated with smoking cessation at 2 and time 3, regardless of intervention group, we built multivariable models with smoking cessation as the outcome and post intervention levels of the mediators as the main predictor. These regression models controlled for age, gender, race, education and income but did not control for intervention group since we were testing for association of the variables with smoking cessation regardless of intervention group.

Results

The prevalence of smoking was 42.5% among the apprentices in the intervention group and 39.8% among those in the control group (p=0.35). Even though the overall prevalence of smoking among all apprentices was 40%, 61% reported that they have smoked in the last 30 days. There was a high interest in smoking cessation in this group with 70% of them reporting that they plan to quit in the next six months while a smaller percent (47.8%) reported that they plan to quit in the next 30 days. As shown in table 1, there were statistically significant differences between the intervention and control groups at baseline by gender, race and income. These differences were due to differences in these characteristics by worksite (our unit of randomization). There were mostly men in our study and in one intervention site, our cohort included only men. Then, the differences in race and income arose because 50% of the apprentices who were not White, Hispanic or Black were at one site, which was an intervention site and 45% of those who made equal to or greater than $75,000 came from one intervention site. We controlled for these variables in all multivariable regression analyses.

Which variables did the intervention change?

Table 2 presents the results of the multivariable models of the relationship between being in the intervention group and change in scores for the psychosocial variables. Compared to the apprentices in the control group, those in the intervention group were more likely to decrease their post-intervention rating of health risk from exposure to occupational hazards and smoking compared to smoking alone (Table 2—Model 2; β=−.22, p=.006). The intervention was not associated with significant change in how the apprentices in the intervention versus control group rated their decisional balance (Table 2—Model 1; β=−.152, p=.22).

Which variables were associated with smoking cessation?

Table 3 and 4 summarize the relationship between post-intervention levels of the psychosocial variables and smoking cessation in time 2 and 3. Based on our hypothesis, we expected that those who had high scores on the psychosocial variables would be more likely to quit smoking regardless of their intervention group. A one point increase in dual hazard score was associated with more than double the odds of smoking cessation at time 2 (OR 2.45; 95% CI 1.75 to 3.43) and nearly double the odds of smoking cessation at time 3 (OR 1.76; 95% CI 1.17 to 2.64). Likewise, each point increase in decisional balance was associated with higher odds of smoking cessation at time 2 (OR 1.23; 95% CI 1.03 to 1.48) but not at time 3 (OR 1.19; 95% CI 0.93 to 1.53).

What happened with dual hazard?

These psychosocial variables are not eligible to be mediators of the MassBUILT intervention. The intervention did not change decisional balance. It decreased scores on dual hazard but it was an increase, not a decrease, in the variable that is associated with smoking cessation. To understand what happened, we examined change in the responses to questions that capture dual hazard (table 5). These results show that the intervention did not make a difference in its key messages. Apprentices in the intervention group significantly increased their rating of the health risk from smoking between baseline and the two outcome points, but there were no differences in how they rated their risks from occupational hazard alone or the combination of occupational hazard and smoking.

Discussion

This present analysis sought to investigate the role of two psychosocial variables (dual hazard and decisional balance), informed by the social contextual framework, which were the main targets of the MassBUILT smoking cessation intervention. As we hypothesized, high levels of both variables were associated with smoking cessation. However, although both were explicitly targeted by the intervention, we found that the intervention did not change decisional balance and it decreased, instead of increased, the apprentices' perception of risk from dual hazard. Further analysis revealed that the effect on dual hazard was primarily due to the effect that the intervention had on the apprentices' perception of risk from smoking, which is that as a result of the intervention, the apprentices perceived smoking to be more hazardous. The study results reveal that the hypothesized mediators did not play a role in smoking cessation among the MassBUILT cohort.

It is important to consider some limitations to our study prior to discussing possible implications of our results. We relied on self report for measurement of the outcome and predictors and could not implement biochemical or respiratory verification of smoking status in this study. The need for validation of smoking cessation in population based studies has been questioned (Murray, Connett, Istvan, Nides, & Rempel-Rossum, 2002; Velicer et al., 1995). Also, the variables involve psychosocial processes that are only feasible to collect as self-report. We made sure that all variables were collected using the same method at all study periods and used validated scales where available. Contamination of the intervention was possible in our study because it was possible that the apprentices, while separated in the study by control and intervention training sites, worked together at the same worksites. We expect that such contamination, if it occurred, would attenuate the overall effects of the intervention but would not change the ability to assess the mediators through which the intervention was effective. Lastly, the results of the study suggest that there were other mediators through which the intervention had its effect and it is likely that these mediators were not assessed in the study. We considered response burden in the design of our survey and chose to only collect information on mediators based on *a priori* hypotheses.

The strengths of our study include our prospective and group randomized controlled design. This study design allowed us to examine longitudinal changes in the mediators and to compare the pre and post intervention changes to a control group that did not get the intervention. Without this comparison, we would not have known that the changes in the psychosocial variables were not significant. Both variables significantly changed pre and post intervention but the changes were not significantly different between the intervention and control groups. The group randomized design of the study increased the internal validity of the study and decreased selection bias because sites were randomly assigned to treatment group. Therefore, sites with apprentices who were more or less motivated to quit smoking were equally distributed across intervention and control groups.

Implications for Practice

Our study has several implications for current work on smoking cessation among blue-collar workers. Other mediation analyses of multi-component interventions have produced similar results where the intervention was effective but the hypothesized mediators were not found to be mediators of the effect (Calfas, Sallis, Oldenburg, & Ffrench, 1997; Haerens, Cerin, Deforche, Maes, & De Bourdeaudhuij, 2007; Lubans & Sylva, 2007). It is possible that the intervention, as a multi-component unit, had a direct effect on smoking cessation. In that case, the various components of our intervention worked synergistically to facilitate smoking cessation among the apprentices in the intervention group and their effects cannot be decomposed. On the other hand, it is possible that there are other factors that actually did fully or partially mediate the effects of the intervention. The fact that these factors were not our hypothesized mediators and thus not the focus of the intervention, could have contributed to the smoking relapse that we found at time 3.

Another important implication of our study is that it supported the theoretical basis of our intervention even as it revealed that the intervention did not achieve one of its main objectives. Using the social contextual model and formative work from the pilot study, we diagnosed that an understanding of the dual hazard from occupational hazard and smoking will lead to an increase in smoking cessation. Our results show that high scores on this concept were associated with improved smoking cessation. In fact, a one point increase in the variable was associated with double the rate of smoking cessation, regardless of intervention group. We cannot credit our study with increasing this awareness but other studies can use this information in designing smoking cessation interventions for blue-collar workers.

The main message of dual hazard is that smoking works synergistically with occupational hazard to decrease health. Our study did not succeed in driving this message home. However, we significantly increased the perception of smoking as hazardous to health among those in the intervention group. That this generic message, which the apprentices possibly get through other sources including the warning labels on cigarette packs, had such an impact on the apprentices point to a possibility that smoking was not viewed negatively among the apprentices at baseline. The high prevalence of smoking in this population along with the finding that we did not change the apprentices' perception regarding the benefits and barrier to smoking, warrant an examination of what drives smoking behaviors in this population. It is possible that there is a need to expand on the model used in the intervention and not just hone in on the work-related aspects of smoking behavior. We recommend that future interventions devote more time before implementation of the intervention to formative research using both qualitative and quantitative methods. Through formative research, interventionist can understand how smoking is viewed and experienced by the apprentices. In addition, formative research could help interventionists understand what the smokers in the study believe would have helped them quit and what in their environment would need to be changed to encourage prolonged smoking cessation.

Interventions to improve smoking cessation among blue-collar populations have produced mixed results and many have been unsuccessful (Campbell et al., 2002; Moher et al., 2005; Sorensen et al., 2004; Willemsen et al., 1998). The MassBUILT intervention was successful; however, the effects of the intervention did not last beyond six months. The test of mediation showed that the intervention did not significantly change smoking decisional balance among the apprentices. Smoking decisional balance captures a weight of how people see the barriers versus benefits of smoking. That the study did not impact how the apprentices weigh the barriers versus benefits of smoking could have contributed to the significant relapse at the end of the study.

The perceived benefits evaluated by the decisional balance scale include smoking's ability to relieve tension, improve concentration and induce relaxation while the barriers were embarrassment at smoking, concern about smoke from cigarette bothering other people and feeling foolish for ignoring warnings about harm of smoking. Our intervention did not change how the apprentices view these benefits and barriers. Future interventions could include more interactive sessions to address the possibility of an entrenched view of smoking as beneficial in a setting such as this where 40% of the participants were current smokers and 61% smoked in the last 30 days. For example, the Toxics and Tobacco curriculum could have been modified to start with a group discussion of smoking. This session would involve both smokers and non-smokers and could include an evaluation of the benefits and barriers of smoking as perceived by the apprentices. In addition, given the evidence of a dose-response relationship between number of smoking cessation sessions and smoking cessation (Fiore et al., 2008), the number of group sessions in the intervention could have been increased to include more class time for discussion of the benefits and barriers to smoking.

In conclusion, our study underscores the importance of examining the how interventions affect psychosocial variables through which the interventions are supposed to operate. The significant smoking relapse in our intervention could have been interpreted to indicate a failure of the theoretical basis of our intervention. However, our analysis show that the psychosocial variables were important to smoking cessation but our intervention did not have the desired effects on these variables. Few studies exist on psychosocial correlates of smoking cessation in worksite interventions with which to compare our results. Further studies are needed to test mediators of worksite based smoking cessation intervention because even negative findings can help interventionists understand what variables are related to smoking cessation and if the different components of the worksite intervention can be decomposed.

Acknowledgments

Grant Sponsor: National Institutes of Occupational Safety and Health and Robert Wood Johnson Health and Society Scholars Program; Grant Number: 1R01 DP000097-01

References

Albertsen K, Hannerz H, Borg V, Burr H. Work environment and smoking cessation over a five-year period. Scand J Public Health. 2004; 32(3):164–171. [PubMed: 15204176]

Armitage CJ. Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioral and implementation intentions. J Occup Health Psychol. 2007; 12(4):376–390. [PubMed: 17953496]

Barbeau EM. Addressing class-based disparities related to tobacco: working with labor unions. Cancer Causes Control. 2001; 12(1):91–93. [PubMed: 11227929]

Barbeau EM, Krieger N, Soobader MJ. Working class matters: socioeconomic disadvantage, race/ethnicity, gender, and smoking in NHIS 2000. Am J Public Health. 2004; 94(2):269–278. [PubMed: 14759942]

Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol. 1986; 51(6):1173–1182. [PubMed: 3806354]

Calfas KJ, Sallis JF, Oldenburg B, Ffrench M. Mediators of change in physical activity following an intervention in primary care: PACE. Prev Med. 1997; 26(3):297–304. [PubMed: 9144753]

Campbell MK, Tessaro I, DeVellis B, Benedict S, Kelsey K, Belton L, et al. Effects of a tailored health promotion program for female blue-collar workers: health works for women. Prev Med. 2002; 34(3):313–323. [PubMed: 11902848]

Fiore, M.; Bailey, W.; Cohen, S. Clinical practice guideline. Rockville, MD: DHHS; 2000. Treating tobacco use and dependence.

Fiore, M.; Jaen, C.; Baker, T.; Bailey, W.; Benowitz, N.; Curry, S., et al. D. o. H. a. H. Services. Treating Tobacco Use and Dependence: 2008 Update. Rockville, MD: Public Health Service; 2008.

Haerens L, Cerin E, Deforche B, Maes L, De Bourdeaudhuij I. Explaining the effects of a 1-year intervention promoting a low fat diet in adolescent girls: a mediation analysis. Int J Behav Nutr Phys Act. 2007; 4:55. [PubMed: 17996087]

King G, Honaker J, Joseph A, Scheve K. Analyzing Incomplete Political Science Data: An Alternative Algorithm for Multiple Imputation. American Political Science Review. 2001; 95(1):49–69.

Lee DJ, Fleming LE, Arheart KL, LeBlanc WG, Caban AJ, Chung-Bridges K, et al. Smoking rate trends in U.S. occupational groups: the 1987 to 2004 National Health Interview Survey. J Occup Environ Med. 2007; 49(1):75–81. [PubMed: 17215716]

Lubans DR, Sylva K. Mediators of change following a senior school physical activity intervention. J Sci Med Sport. 2007

Migneault JP, Adams TB, Read JP. Application of the Transtheoretical Model to substance abuse: historical development and future directions. Drug Alcohol Rev. 2005; 24(5):437–448. [PubMed: 16298839]

Moher M, Hey K, Lancaster T. Workplace interventions for smoking cessation. Cochrane Database Syst Rev. 2005; (2):CD003440. [PubMed: 15846667]

Murray RP, Connett JE, Istvan JA, Nides MA, Rempel-Rossum S. Relations of cotinine and carbon monoxide to self-reported smoking in a cohort of smokers and ex-smokers followed over 5 years. Nicotine & Tobacco Research. 2002; 4(3):287. [PubMed: 12215237]

Nelson DE, Emont SL, Brackbill RM, Cameron LL, Peddicord J, Fiore MC. Cigarette smoking prevalence by occupation in the United States. A comparison between 1978 to 1980 and 1987 to 1990. J Occup Med. 1994; 36(5):516–525. [PubMed: 8027876]

Okechukwu C, Krieger N, Sorensen G, Yi L, Barbeau E. Massbuilt: Effectiveness of an Apprenticeship Site-Based Smoking Cessation Intervention for Unionized Building Trades Workers. Cancer Causes and Control. 2009; 20(6):887–894. [PubMed: 19301135]

Sorensen G, Barbeau E, Hunt M, Emmons K. Reducing social disparities in tobacco use: A social contextual model for reducing tobacco use among blue collar workers. American Journal of Public Health. 2004; 94(2):230–239. [PubMed: 14759932]

Sorensen G, Barbeau EM. Integrating occupational health, safety and worksite health promotion: opportunities for research and practice. Med Lav. 2006; 97(2):240–257. [PubMed: 17017356]

Sorensen G, Emmons K, Stoddard AM, Linnan L, Avrunin J. Do social influences contribute to occupational differences in quitting smoking and attitudes toward quitting? Am J Health Promot. 2002; 16(3):135–141. [PubMed: 11802258]

Sorensen G, Stoddard A, Hammond SK, Hebert JR, Avrunin JS, Ockene JK. Double jeopardy: workplace hazards and behavioral risks for craftspersons and laborers. Am J Health Promot. 1996; 10(5):355–363. [PubMed: 10163305]

State Building and Construction Trades Council of California. BUILT: State Building & Construction Trades Council of California. 2006.

Sterling TD, Weinkam JJ. Smoking characteristics by type of employment. J Occup Med. 1976; 18(11):743–754. [PubMed: 993866]

US Census Bureau. D. Housing and Household Economic Statistics Division. Poverty Thresholds for 2005 by Size of Family and Number of Related Children Under 18 Years. 2006.

Velicer WF, DiClemente CC, Prochaska JO, Brandenburg N. Decisional balance measure for assessing and predicting smoking status. J Pers Soc Psychol. 1985; 48(5):1279–1289. [PubMed: 3998990]

Velicer WF, Fava JL, Prochaska JO, Abrams DB, Emmons KM, Pierce JP. Distribution of smokers by stage in three representative samples. Prev Med. 1995; 24(4):401–411. [PubMed: 7479632]

Ward RM, Velicer WF, Rossi JS, Fava JL, Prochaska JO. Factorial invariance and internal consistency for the decisional balance inventory--short form. Addict Behav. 2004; 29(5):953–958. [PubMed: 15219341]

Willemsen MC, de Vries H, van Breukelen G, Genders R. Long-term effectiveness of two Dutch work site smoking cessation programs. Health Educ Behav. 1998; 25(4):418–435. [PubMed: 9690101]

Health Educ Behav. Author manuscript; available in PMC 2012 September 14.

Table 1

Demographic characteristics of apprentices who smoke in the MassBUILT study (n=490)[a]

Characteristic	Intervention		Control		
	n	%	n	%	p-value
Gender					
Male	217	92.7	240	97.2	0.03
Female	17	7.3	7	2.8	
Missing gender	18		11		
Race					
Hispanic	5	2.2	3	1.3	0.03
Black	16	7.1	5	2.1	
Additional Race/Ethnicities	8	3.5	15	6.3	
White	197	87.2	216	90.1	
Missing race	41		33		
Education					
Less than high school	4	1.8	7	1.3	0.71
High school or GED	122	53.5	117	49.2	
Some college or 2 yr degree	87	38.2	98	41.2	
4 yr college or more	15	6.6	20	8.4	
Missing education	37		25		
Income					
<$25,000	20	9.8	13	5.8	0.04
$25,000–$49,999	82	40.2	80	35.9	
$50,000–74,999	57	27.9	55	24.7	
≥$75,000	45	22.1	75	33.6	
Missing income	95		90		
Smoking Intensity					
Less than half pack	82	34.9	107	42.9	0.22
Half to full pack	99	42.1	95	38.2	
One to two packs	46	19.6	42	17.3	
More than two pack	8	3.4	4	1.6	
	Mean	SD	Mean	SD	

Characteristic	Intervention		Control		
	n	%	n	%	p-value
Age of smoking initiation	16.5	3.5	16.8	3.7	0.46
Current age	27.5	6.1	28.3	6.3	0.15

[a]Totals do not add up to the same number b/c values were calculated prior to imputing missing covariantes

Table 2

Which variables did the MassBUILT intervention change? The relationship between intervention group and change in psychosocial variables (n=490) *

	Model 1: Decisional Balance		Model 2: Dual Hazard	
Variable	**Estimate**	***p*-value**	**Estimate**	***p*-value**
Intervention group vs. control	.152	0.22	−.22	.006

*Controlling for baseline values, age, gender, race, education and income

Table 3

Which variables were associated with smoking cessation at time 2? The relationship between post-intervention levels of the psychosocial variables and smoking cessation at time 2 (n=490) *

	Model 1	Model 2
Variable	**OR (95% CI)**	**OR (95% CI)**
Decisional Balance	1.23 (1.03,1.48)	
Dual Hazard		2.45 (1.75,3.43)

* Controlling for age, gender, race, education and income

Table 4

Which variables were associated with smoking cessation at time 3? The relationship between post-intervention levels of the psychosocial variables and smoking cessation at time 3(n=490) *

	Model 1	Model 2
Variable	**OR (95% CI)**	**OR (95% CI)**
Decisional Balance	1.19 (0.93,1.53)	
Dual Hazard		1.76 (1.17,2.64)

* Controlling for age, gender, race, education and income

Table 5

Did the intervention change perception of risk from smoking, occupational hazard and combination of smoking and occupational hazard? The relationship between intervention group and change in questions (n=490) *

	Model 1: Smoking		Model 2: occupational hazard		Model 3: smoking and occupational hazard	
Variable	**Estimate**	***p*- value**	**Estimate**	***p*-value**	**Estimate**	***p*-value**
Intervention group vs. control	.266	0.0002	.006	0.7	.053	.32

* Controlling for age, gender, race, education and income